6. Electricity

6.1 Forecasting Demand and Supply for Electricity

The ENERGY 2020 model contains the factors which influence the behavior of the electricity supply sector, including capacity expansion/construction decisions, rates and prices, load shape variation due to weather, changes in regulation, and wholesale and retail pricing.[1]

The electric sector of the model can simulate the full spectrum of deregulated markets, including the independent system operator (ISO), as we have in New England. The model dispatches plants according to ISO-NE rules, whether they are precisely and perfectly least-cost, or if they reflect other practical rules of dispatch which do not perfectly minimize costs. The model also recognizes transmission constraints as well as the associated costs.[2] A sophisticated dispatch routine selects critical hours along seasonal load duration curves as a way to provide a quick but accurate determination of system generation. Peak and base hydro usage is explicitly modeled to capture hydro plant impacts on the electric system. For the NH Energy Plan, the deregulation dynamics are not a focus and the model is set to produce a conservative dispatch where suppliers act to minimize societal costs consistent with their individual generation costs.

6.2 Electricity Demand Forecast

The ENERGY2020 Base Case forecast projects total electricity sales to grow at a rate of 3.1% over the forecast period. Electricity sales growth is led by the industrial sector with a 4.3% growth rate. The commercial sector remains the largest class with an average growth rate of 3.2%. The peak load growth rate is similar to the sales growth rate implying little change in the load factor. Table 6.1 summarizes the forecast values of electric sales and peak demand.

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[1] Gas transmission data are provided by CERI and electric transmission data provided by Resource Data, International via the National Electric Reliability Council. The dispatch technologies present in the New Hampshire ENERGY2020 model include: Oil/Gas Combustion turbine, Oil/Gas Combined Cycle, Oil/Gas Steam Turbine, Coal Steam Turbine, Advanced Coal, Nuclear, Baseload Hydro, Peaking Hydro, Renewables, Baseload Purchase Power Contracts, Baseload Spot Market, Intermediate Purchase Power Contracts, Intermediate Spot Market, Peaking PP Contracts, Peaking Spot Market, and Emergency Purchases.

[2] A 70-node transmission system is used in the New Hampshire model.

6.3 Electricity Supply Forecast

As discussed in Chapter 5, one of the realities for most states in the US, including New Hampshire, is that its energy market is part of a regional market. Changes in demand by New Hampshire energy users are responded to by changes in electric power production at the regional level, not necessarily at the state level. These responses will in some cases influence generation from New Hampshire power plants, while in many cases they will not. This is true both in the short term (in which existing electric power plants change their levels of generation) and in the long term (in which investors decide whether and when to construct new generating capacity).

Table 6.1 Electric Sales and Peak Demand

Base Case Forecast Electric Sales and Peak Demand by Class						
	1990	**2000**	**2005**	**2010**	**2015**	**2020**
	Electric Sales (GWh/Year)					
Residential	3,444	3,734	4,099	4,633	5,174	5,608
Commercial	2,117	3,909	4,712	5,743	6,691	7,351
Industrial	3,418	2,635	3,484	4,545	5,592	6,278
Transportation	0	0	0	0	0	0
Street/Misc	107	127	127	127	127	127
Total Sales (GWh)	**9,086**	**10,405**	**12,422**	**15,048**	**17,585**	**19,364**
	Peak Load (MW)					
Winter Peak	2,469	1,881	2,222	2,673	3,109	3,413
Summer Peak	2,475	1,826	2,172	2,623	3,056	3,358
	Cumulative Growth Rate of Electricity Sales					
Residential	0.8%	0.0%	1.9%	2.2%	2.2%	2.0%
Commercial	6.1%	0.0%	3.7%	3.9%	3.6%	3.2%
Industrial	-2.6%	0.0%	5.6%	5.5%	5.0%	4.3%
Transportation	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Street/Misc	1.7%	0.0%	0.0%	0.0%	0.0%	0.0%
Total Sales	**1.4%**	**0.0%**	**3.5%**	**3.7%**	**3.5%**	**3.1%**
	Cumulative Growth Rate of Peak Load					
Winter Peak	-2.7%	0.0%	3.3%	3.5%	3.4%	3.0%
Summer Peak	-3.0%	0.0%	3.5%	3.6%	3.4%	3.0%

In the Base Case, electric generating capacity is unchanged except for the already planned addition of 1080 MW of gas combined cycle capacity and 280 MW of combustion turbines and the retirement 77.6 MW of biomass capacity. Table 6.2 summarizes the forecasted values of generating capacity.

Table 6.2 Generating Capacity

Base Case Forecast New Hampshire Generating Capacity (MW)					
	2000	**2005**	**2010**	**2015**	**2020**
Gas/Oil Turbines	13.0	293.0	293.0	293.0	293.0
Gas/Oil Combined Cycle	0.0	1080.0	1080.0	1080.0	1080.0
Gas/Oil Steam	511.0	511.0	511.0	511.0	511.0
Coal Steam	570.0	570.0	570.0	570.0	570.0
Nuclear	1161.0	1231.0	1231.0	1231.0	1231.0
Hydro	440.0	440.0	440.0	440.0	440.0
Biomass	77.6	63.8	0.0	0.0	0.0
Landfill Gas/Waste	19.6	19.6	19.6	19.6	19.6
Wind	0.0	0.0	0.0	0.0	0.0
Total	**2792.2**	**4208.4**	**4144.6**	**4144.6**	**4144.6**

Electric generation follows a similar pattern as capacity, with higher amounts of gas combined cycle and combustion turbine generation and an elimination of biomass generation. Table 6.3 summarizes the Base Case forecast of generation by plant.

Table 6.3 New Hampshire Generation by Plant

Base Case Forecast New Hampshire Generation by Plant (GWh)					
	2000	**2005**	**2010**	**2015**	**2020**
Gas/Oil Turbines	46	389	641	972	1,167
Gas/Oil Combined Cycle	0	927	1,606	2,903	5,108
Gas/Oil Steam	1,562	1,562	1,562	1,562	1,562
Coal Steam	3,286	3,286	3,286	3,286	3,286
Nuclear	8,684	9,208	9,208	9,208	9,208
Hydro	1,348	1,348	1,348	1,348	1,348
Biomass	589	484	0	0	0
Landfill Gas/Waste	159	159	159	159	159
Wind	0	0	0	0	0
Total	**15,674**	**17,362**	**17,810**	**19,438**	**21,838**

Table 6.4 summarizes forecasted values for New Hampshire’s wholesale price of electricity. As noted in the summary table, the annual wholesale price of electricity is expected to grow at a real rate of 3.4% over the forecast period. The winter wholesale price grows at 3.4%, while the summer price grows at 3.5%.

Table 6.4. Average Wholesale Price

Base Case Forecast New Hampshire Average Wholesale Price ($/MWh)					
	2000	**2005**	**2010**	**2015**	**2020**
			Nominal Dollars		
Summer	68.78	50.92	74.20	107.76	137.28
Winter	54.21	34.01	50.42	76.20	107.02
Annual	61.61	42.58	62.46	92.17	122.33
			2000 Dollars		
Summer	68.78	44.79	56.84	71.91	79.80
Winter	54.21	29.91	38.63	50.85	62.20
Annual	61.61	37.45	47.85	61.51	71.11
			Real Cumulative Growth Rate (%)		
Summer	0.0%	-6.0%	0.8%	3.0%	3.5%
Winter	0.0%	-9.3%	-0.7%	2.3%	3.4%
Annual	0.0%	-7.4%	0.1%	2.7%	3.4%

In summary, the Base Case forecast for electricity demand and supply calls for considerable growth in industrial electricity consumption, which will make state electricity consumption grow faster than the state's population. Due in part to current and near-term additions of generation capacity in the region, electricity prices are forecast to continue their recent declines through most of the next ten years, after which time a tightening regional supply situation is forecast to bring prices back up again as we approach 2020.

6.4 Electricity Scenarios Relative to Base Case

Two electric scenarios were created in response to stakeholder input suggesting that the impacts of premature closure of one or more of New Hampshire's baseload electricity generating stations should be tested. One of these scenarios tests the impact of closing New Hampshire's two coal-fired power plants, Schiller and Merrimack stations, in Portsmouth and Bow respectively.

The concept for this scenario stems from the possibility that future environmental regulations, the age of the plants, fuel supply issues, economic conditions, or a combination of these factors could potentially lead to the closure of these plants by 2020. The value of this scenario is to more fully understand the importance of these facilities to New Hampshire's energy future, and the impacts that their closure would have on energy costs, fuel diversity, the environment, and other factors.

The second scenario is the premature closure of the Seabrook nuclear power station. This scenario, albeit highly unlikely, is based on the conceptual possibility that a terrorist threat or "homeland security" considerations might lead to such a shutdown of nuclear plants. The scenario is also of interest because Seabrook's capacity and generation are such a significant share of the total capacity and generation in New Hampshire. The value of this policy scenario, as with the coal plant closure, is to more fully understand Seabrook's role in New Hampshire's energy future, and the impacts of its closure on several variables.

It cannot be over-emphasized that these scenarios were run in order to undertsand the impacts of such plant closures, and are not meant to serve as recommendations to close the facilities, which at this point are very important to the electricity supply of New Hampshire and New England.

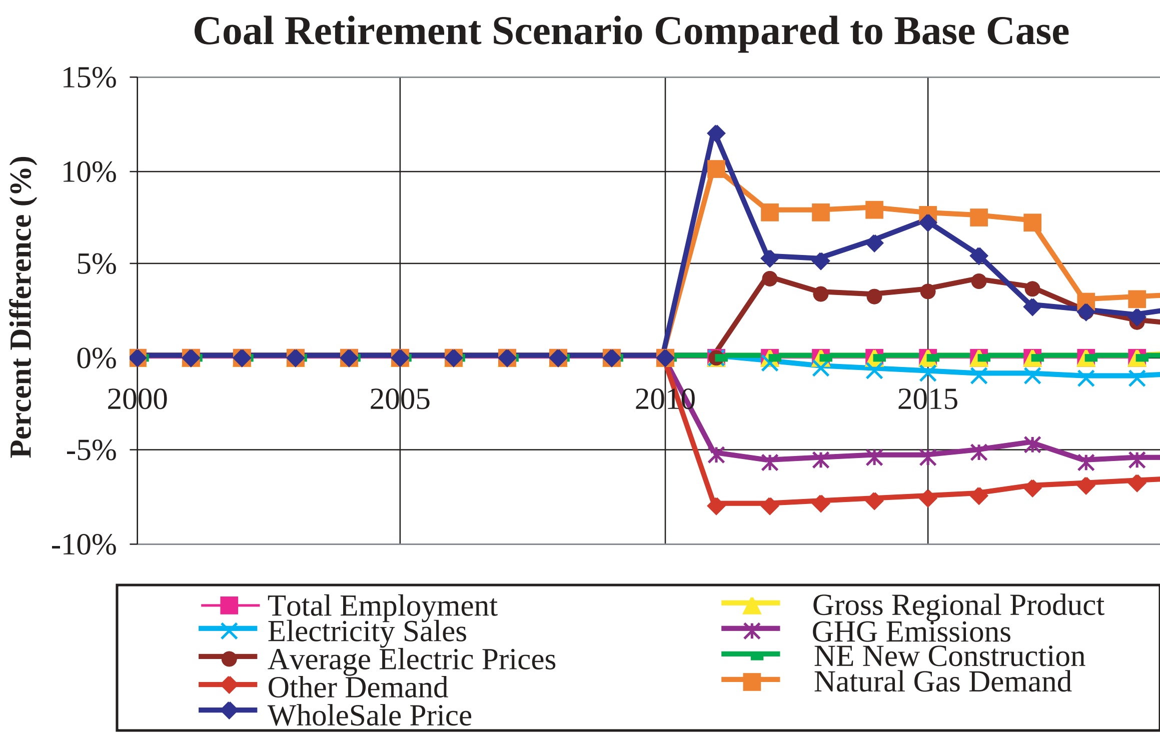

Figure 6.1. Impacts of Coal Plants Shutdown Relative to Base Case

6.4.1 Hypothetical Coal Plant Closure

New Hampshire has two coal-fired power plants, both presently owned and operated by PSNH. Merrimack Station on the Merrimack River in Bow is PSNH's prime base-load plant with a net generation capacity of 433.5 megawatts from its two coal-fired units. Unit One has a net capacity of 113.5 MW; Unit Two has a net capacity of 320 MW.

The plant is supplied by roughly 1 coal train per week from Pennsylvania, Virginia or Kentucky coal mines. PSNH's other coal-fired facility, Schiller Station, is on the Piscataqua River in Portsmouth. The source of coal used in this facility varies based upon price, availability and sulfur content. This plant has obtained coal by barge from Virginia or by ship from Venezuela or Nova Scotia.

In order to understand the role these plants play in New Hampshire's energy future, as well as the impact of losing the generation from these plants, we modeled the hypothetical shutdown of New Hampshire's two coal-fired power stations occurring in 2011. The effects of this shutdown on the set of key variables, relative to the Base Case, are illustrated in Figure 6.1. Overall, the wholesale electricity price rises sharply (over 10%) in the first year and then recovers during subsequent years to a level 2-3% higher than its base case level by 2020. Retail prices rise by a more modest percentage, under 5% for the duration of the simulated impacts.

Table 6.5. Electricity Sales Impacts of Coal Plant Retirement

New Hampshire Electricity Sales (GWh/Year)						
	2000	2005	2010	2015	2020	20 Year Average
Base Case Comparison						
Base Case	10,405	12,422	15,048	17,585	19,364	**15,199**
Coal Retire Coall	10,405	12,422	15,048	17,445	19,177	**15,132**
Difference	0	0	0	-139	-187	**-67**
Percent Change	0.00%	0.00%	0.00%	-0.79%	-0.96%	**-0.44%**
High Price Scenario Comparison						
High Price	10,405	12,422	15,173	18,156	20,205	**15,481**
Coal Retire HP C	10,405	12,422	15,173	18,003	20,193	**15,466**
Difference	0	0	0	-153	-12	**-15**
Percent Change	0.00%	0.00%	0.00%	-0.88%	-0.06%	**-0.10%**

Figure 6.1 also shows that natural gas generation would pick up the deficit created by the loss of the coal plants. Natural gas plants provide electricity with lower CO_2 emissions per kWh, so total NH greenhouse gas emissions would drop as a result of the shutdown, by approximately 5%, or 3 million tons of CO_2 (see Table 6.7). Because the retail price of electricity would rise, the total demand for electricity would fall slightly, by approximately 1%. Electricity price and demand responses are also summarized in Table 6.5 and Table 6.6.

Table 6.6. Electricity Price Impacts of Coal Plants

Average Electric Prices (2000 $/MWh)						
	2000	2005	2010	2015	2020	20 Year Average
Base Case Comparison						
Base Case	98.67	79.38	69.65	79.42	88.35	**79.61**
Coal Retire	98.67	79.38	69.65	82.19	89.73	**80.72**
Difference	0.00	0.00	0.00	2.76	1.38	**1.11**
Percent Change	0.00%	0.00%	0.00%	3.48%	1.56%	**1.33%**
High Price Scenario Comparison						
High Price	98.67	79.38	69.73	82.42	91.18	**80.97**
Coal Retire HP	98.67	79.38	69.73	85.33	96.25	**82.23**
Difference	0.00	0.00	0.00	2.90	5.07	**1.26**
Percent Change	0.00%	0.00%	0.00%	3.52%	5.57%	**1.44%**

Finally, we investigated the impacts of the higher electricity price and the loss of the plant upon the state's economy. As shown in Table 6.8 the early impact is negative, with a net loss of 160 jobs relative to the Base Case in 2015. Table 6.8 also shows the results in the context of the high fuel price scenario, which in 2015 amount to a loss of 136 jobs relative to the no-shutdown, high price scenario.

Table 6.7. Greenhouse Gas Emission Impacts of Coal Plant Retirement

Greenhouse Gas Emissions (Million Tons CO2e/Year)	2000	2005	2010	2015	2020	20-Year Average
Base Case Comparison						
Base Case	36.37	40.48	46.16	51.63	56.07	**46.94**
Coal Retire CoalI	36.37	40.48	46.16	48.90	53.01	**45.55**
Difference	0.00	0.00	0.00	-2.73	-3.07	**-1.39**
Percent Change	0.00%	0.00%	0.00%	-5.29%	-5.47%	**-2.55%**
High Price Scenario Comparison						
High Price	36.37	40.48	45.12	48.03	52.73	**45.17**
Coal Retire HP C	36.37	40.48	45.12	45.36	49.45	**43.78**
Difference	0.00	0.00	0.00	-2.67	-3.28	**-1.40**
Percent Change	0.00%	0.00%	0.00%	-5.57%	-6.21%	**-2.73%**

Interestingly, the energy-economic modeling system actually predicts an increase in employment by the year 2020 compared to Base Case resulting from the closure of the coal plants. The gains in jobs relative to the respective no-shutdown cases are roughly 1,500 jobs relative to the Base Case, and over 17,000 jobs in the event of the fuel price shock. The reason for these longer-term economic gains for the state is the fact that with the sustained, slightly higher retail electricity rates starting in 2011, the state's businesses and homeowners invest in higher energy efficiency as they buy new capital stocks or replace worn-out stocks and equipment in response to higher prices.

Table 6.8. Employment Impacts of Coal Plant Retirement

Total Employment (Thousands)	2000	2005	2010	2015	2020	20-Year Average
Base Case Comparison						
Base Case	699.797	741.202	777.134	813.023	842.421	**779.501**
Coal Retire CoalRe	699.797	741.202	777.134	812.863	843.959	**779.518**
Difference	0.000	0.000	0.000	-0.160	1.538	**0.017**
Percent Change	0.00%	0.00%	0.00%	-0.02%	0.18%	**0.00%**
High Price Scenario Comparison						
High Price	699.797	741.202	773.287	806.896	846.290	**776.937**
Coal Retire HP Co	699.797	741.202	773.287	806.760	863.465	**780.986**
Difference	0.000	0.000	0.000	-0.136	17.175	**4.050**
Percent Change	0.00%	0.00%	0.00%	-0.02%	2.03%	**0.46%**

These investments create a positive impact on the economy and result in the creation of new jobs as the energy efficiency goods and services are produced and delivered in the state.

While the economy does not shrink overall due to the closure of the coal plants, by 2015 total electricity sales in the state would drop by nearly 1%. This drop represents increased efficiency, which pays longer-term economic dividends by 2020 as the state's businesses are more cost-competitive relative to the Base Case. The benefits of these efficiency gains are quite large in the case of the fuel price shock because the fuel price shock leads to a combination of higher electricity prices and higher fuel shares for electricity. Under the conditions of a hypothetical price shock, the economic benefits to New Hampshire's economy of the coal shutdown-induced efficiency gains are quite significant: 2% of total state employment in 2020.

The electricity provided by New Hampshire's coal plants are important to the state, and this hypothetical scenario shows these plants help make electricity in the state more affordable. In the event that these plants were closed in the near term, it is important to understand the economic, environmental and energy consequences. The model shows that, when compared to the base case scenario, electricity prices – both wholesale and retail – would be higher, emissions of greenhouse gasses would decrease, and the impacts on gross regional product and employment would be quite modest.

6.4.2 Premature Closure of Seabrook

Seabrook Station is New Hampshire's largest electrical generator. Located on an 889-acre site on the coast of New Hampshire in the town of Seabrook, it uses a 1,150 MW pressurized-water nuclear reactor to produce enough power for approximately 1 million New England homes. Florida Power & Light is in the process of purchasing Seabrook Station as a result of the sale of plant after electric restructuring.

Since the September 11, 2001 terrorist attacks, there has been much discussion concerning other potential targets for future terrorist attacks. These have included chemical plants, fuel pipelines, and nuclear power stations, among others. Discussions with stakeholders raised the possible, though far from probable, scenario that policy makers may eventually determine that operation of nuclear power stations presented too great a risk in relation to terrorist attacks. For this reason, and because Seabrook represents such a large share of New Hampshire electricity generating capacity and annual generation, it was determined to be of interest to consider the possible consequences from the premature closure of Seabrook. We selected the arbitrary year of 2005 for the hypothetical closure, in order to provide time (15 years) in the remaining forecast horizon for the consequences to be measurable.

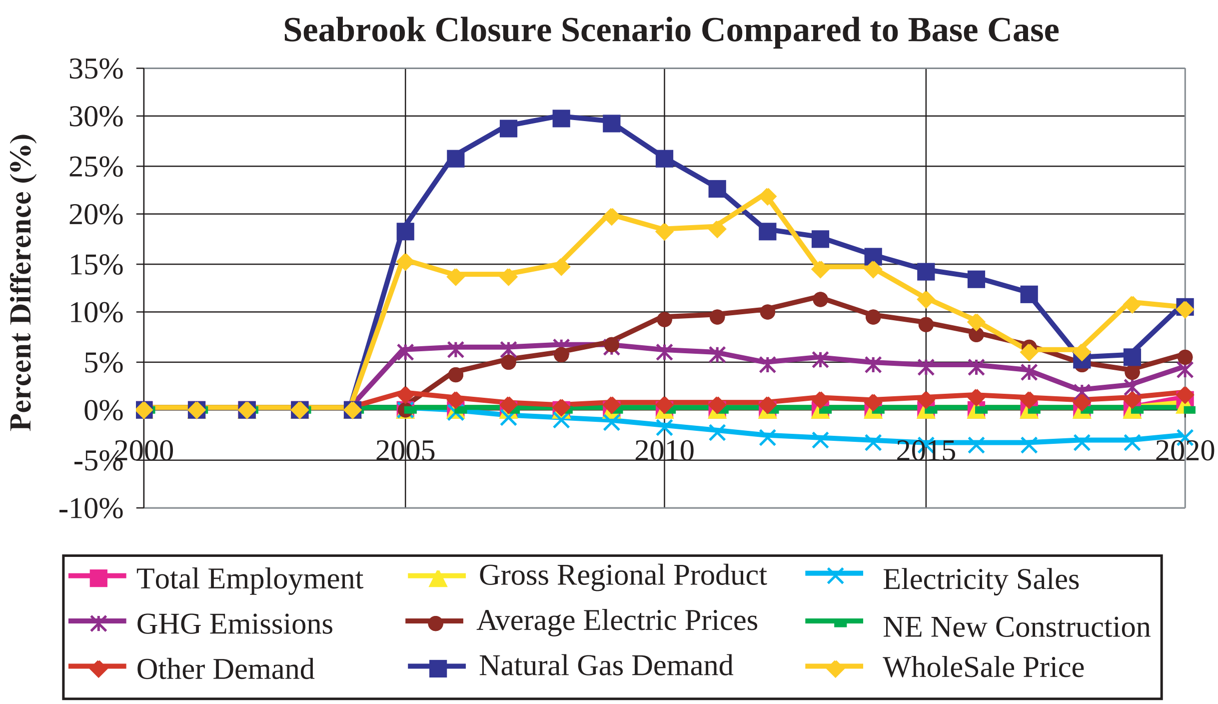

Figure 6.2. Impacts of Seabrook Shutdown versus Base Case

The closure of Seabrook nuclear station in 2005 would lead to some rather significant consequences for the New Hampshire and the New England regional energy system, as summarized in Figure 6.2. The Seabrook shutdown is forecast to cause retail electricity prices to rise by as much as 10%

Table 6.9. Employment Impacts of Seabrook Shutdown

Total Employment (Thousands)	2000	2005	2010	2015	2020	20-Year Average
Base Case Comparison						
Base Case	699.797	741.202	777.134	813.023	842.421	**779.501**
Nuke Retire	699.797	741.202	776.754	812.625	852.079	**779.758**
Difference	0.000	0.000	-0.380	-0.398	9.658	**0.257**
Percent Change	0.00%	0.00%	-0.05%	-0.05%	1.15%	**0.03%**
High Price Scenario Comparison						
High Price	699.797	741.202	773.287	806.896	846.290	**776.937**
Nuke Retire HP	699.797	741.202	772.972	806.651	863.016	**782.104**
Difference	0.000	0.000	-0.315	-0.245	16.726	**5.167**
Percent Change	0.00%	0.00%	-0.04%	-0.03%	1.98%	**0.59%**

relative to the Base Case. As in the hypothetical coal closure scenario, this leads to modest near-term economic impacts, with longer-term economic gains as a result of efficiency improvements. However, with the higher price impact of Seabrook closure, it takes longer (more than 10 years) for the economic impacts to turn positive. In contrast to the coal hypothetical, the closure of Seabrook would cause a major increase in greenhouse gas emissions, as fossil fuels (largely natural gas) would likely replace the lost nuclear generation.

Table 6.10. Effects of Seabrook Shutdown on Average NH Electricity Prices

Average Electric Prices (2000 $/MWh)						
	2000	**2005**	**2010**	**2015**	**2020**	**20 Year Average**
Base Case Comparison						
Base Case	98.67	79.38	69.65	79.42	88.35	**79.61**
Nuke Retire	98.67	79.38	76.13	86.48	93.24	**83.72**
Difference	0.00	0.00	6.49	7.05	4.89	**4.11**
Percent Change	0.00%	0.00%	9.32%	8.88%	5.53%	**5.13%**
High Price Scenario Comparison						
High Price	98.67	79.38	69.73	82.42	91.18	**80.97**
Nuke Retire HP	98.67	79.38	76.18	87.37	99.01	**85.35**
Difference	0.00	0.00	6.45	4.95	7.83	**4.38**
Percent Change	0.00%	0.00%	9.25%	6.01%	8.59%	**5.28%**

Lastly, it is important to note the rather dramatic rise in total New Hampshire natural gas consumption that is forecast to result from the Seabrook closure, which may have other implications with regard to both the supply and price of natural gas in the state and the region.